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BOOK REVIEWS

Resonances : The Unifying Route towards the Formulation of Dynamical Processes—Foundations and Applications in Nuclear, Atomic and Molecular Physics

Proceedings of a Symposium held at Lertopet, Värmland, Sweden, August 19–26, 1987 (Lecture Notes in Physics, Vol. 325)

edited by E Brändas and N Elander

Springer-Verlag : Berlin-Heidelberg-New York-London-Paris-Tokyo-Hong Kong, 1989
xviii+ 564 pages, illustrated; price : DM 116.00 (Hard cover); ISBN 3-540-50994-1

The volume under review presents the proceedings of a 1987 symposium held at Lertopet, Värmland, Sweden with the theme "Resonances : The Unifying route towards the formulation of dynamical events". The spectrum of topics covered is broad, some genuinely inter-disciplinary, ranging from pure mathematics, nuclear and atomic molecular physics, chemical dynamics to topics that are in the domain of biology and medicine.

The volume begins with an introductory article dealing with the notion of a rigged Hilbert space or Gelfand Triplet, an idea which has been used for defining resonances. These ideas pave the way for grafting the theoretical models into an appropriate mathematical framework. The next two articles by Bernad Helffer and Johannes Sjostrand present a brief account of the most sophisticated mathematical theory of resonance based on microlocal analysis of partial differential equations. Most appropriately, this section ends with an article by Eric Balslev, one of the Founding Fathers of the complex scaling method for studying resonances. This article deals with resonances with a background potential and ends with an elegant discussion on the Gamow function associated with an S-wave resonance and mathematical analysis of the so called back rotation problem. The next three articles also belong to what may be called mathematical physics. Thus, while A Melin presents a careful analysis of the problem of direct and inverse scattering for Schrödinger operator in odd space dimensions with a short range potential, L Trlifaj revisits the almost periodic Schrödinger equation (SE), demonstrating that one can treat the one dimensional almost periodic and completely periodic problems on the same footing provided one makes use of the associated modified Milne equations. The author builds up the almost periodic and completely periodic solutions by means of Weyl's solutions to the primary Schrödinger equations, determining at the same time the spectral function, the roots of which demarcate the spectral bands. In a short article that follows, Heinz Sidentrop introduces a new method for obtaining the number

and location of resonances in regions of the complex plane. The methods for localizing resonance eigenvalues may be divided into two groups, namely methods that exclude resonances and methods that provide information about the existence of resonances. Solters article is devoted to getting exclusion bounds on eigenvalues of non-self adjoint operators by using trial (left) inverse operators and affording a generalization of Mullers variational principle.

The next two articles by Berggen and Bang are devoted to the expansion Theorem involving bound states, resonances, *etc*. The illustrative derivation of Briet-Wigher formula by using the resonance state expansion method by Berggren is quite educative as well. These two articles together with the following three, constitute what may be rightly identified as a section on selected applications of the resonance theories in nuclear physics. They include calculation of resonant wave functions in nuclear physics (by B Gyarmati) and the use of Gamow functions in nuclear problems (by T Vertse *et al*). Lidia S Ferreria's examination of resonances as a general eigenvalue problem and exploration of its connection with the scattering theory, with some numerical applications is interesting. I would mention their use of Gamow vectors as a basis set to obtain a separable representation of an interaction following the general method of Adhikari and Sloan as particularly interesting.

A smooth transition is made here to the domain of atomic and molecular physics. The point of view adopted in this section is different in that one resorts to an explicit time-dependent representation directly, instead of transforming the evolution operator or the propagator to unearth analytic properties of the associated resolvent. Thus, J. Revai uses separable interactions due to which the dynamics of time evolution can be solved exactly, the model naturally leading to a study of time-evolution of quasi-stationary states. A time-dependent approach to molecular dynamics involving both nuclei and electrons is presented next by E Deumens and Y Öhrn. The stage is here set for semiclassical descriptions of resonances. H J Korsch reviews the semiclassical quantization of complex energy resonance poles of the S-matrix, extending the theory to various Feshback-type resonances in curve-crossing systems.

The proceedings next focus on multichannel approaches to resonance determination based on a numerical integration of the coupled channel equation supplemented by a matching condition to ensure continuity of the wave function and its derivative over the entire range of integration (R Lefebvre). M A Natiello *et al* also discuss the numerical solution of the multichannel SE to introduce dynamical effects beyond the Born-Oppenheimer approximation. An excellent article by Erkki Brändas on the multi-channel complex scaled Titchmarsh Weyl theory as a model for diatomic fragmentation is a special attraction of this section. They show that the intrinsic simplicity of the theory persists in the multichannel case also.

Before closing the review, I must make mention of an article by C E Reid and E Brändas on the theorem for complex symmetric matrices and its relevance in the study of decay phenomena. The importance of it lies in the fact that in most of the applications of

CSM, one perhaps automatically assumes complex symmetric representation. The theorem referred to asserts that energy matrix can be brought to complex symmetric form by a similarity transformation. The form itself has been shown to be connected with Coherent-dissipative structures (E Brändas and C A Dreismann).

The concluding pages of the proceedings present a very useful discussion and viewpoints regarding the generalized scalar or inner product as they developed during the weeklong symposium, giving the readers who did not attend, a feeling of participation.

Summing up, I can unhesitatingly say that this volume will become an essential companion for any one interested in the study of a phenomena called "resonances". That 'anyone' may perhaps come from any field of science. The benefit would be equal.

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Quantum Mechanics on the Personal Computers
(2nd Edition with a Program Diskette)
by S Brandt and H D Dahmen

Springer-Verlag : Berlin-Heidelbarg-New York-London-Paris-Tokyo-Hong Kong-Barcelona-Budapest, 1992
xii+ 267 pages, 69 figures, 284 exercises; price : DM 98.00 (Hard cover); ISBN 3-540-55722-9

Quantum mechanics describes the microscopic world of atoms, molecules and subatomic particles. It is therefore important for students of physical science and engineering to learn the concepts and methodology of this mechanics for understanding of physical phenomena ranging from conductivity of metals to the twinkling of the stars.

However, one practical difficulty in learning this subject is its inherent abstract nature. Compared to classical mechanics whose laws are amenable to understanding in terms of our experience in daily life the quantum laws are difficult to reconcile with the existing notions of classical physics. With the advent of computers with adequate graphics facility one can, however comprehend a pictorial view of some of the illustrations of the very basic concepts. The aim of the book under review is to present such an interactive picture program of quantum mechanics.

The book contains a main text and several appendices. The chapters 2 to 4 and 6 to 8 discuss the free particle motion, bound states and scattering in one dimension followed by their generalizations in three dimensions. A chapter is devoted to coupled oscillator problem as an example of two-particle system. The Chapter 9 on special functions of mathematical physics is an useful one. Each of these chapters begins with "physical concepts" which , in short, is a collection of concepts and working formulae.

The accompanying program "interactive quanta" can be run on any IBM XT/AT personal computer with just 640 KB memory. It does not assume even any knowledge of fortran and as such it may be useful for any beginner in the subject as a "laboratory course" on quantum mechanics.

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New Methods and Results in Non-linear Field Equations
(Lecture Notes in Physics, Vol. 347)
Proceedings of a Conference held at the University of Bielefeld, FRG, 7–10 July, 1987
edited by Ph Blanchard, J-P Dias and J Stubbe
Springer-Verlag : Berlin-Heidelberg-New York-London-Paris-Tokyo-Hong Kong, 1989
v+ 133 pages, illustrated; price : DM 55.00 (Hard cover); ISBN 3-540-51977-7

The present proceedings on nonlinear field equations, as the name implies, presents some results on particularly three important field equations. These are nonlinear Klein-Gordon, nonlinear Schrödinger and nonlinear Dirac equations which form the cornerstone of some of the most recent developments of field theoretic models.

This volume contains nine articles. The majority of them deal with the basic problems such as Cauchy problem (initial value problem), existence of particular solutions in relation to nonlinear bound states or asymptotic behaviour and the stability of the solutions. The book starts with a perturbation problem of classical dynamical systems by stachastic forces. The Cauchy problem *i.e.* the existence of solutions for a given initial condition for nonlinear Klein-Gordon equation and nonlinear Schrödinger equation has been discussed in two articles. The stability of stationary or quasi-stationary solutions which is particularly important for nonlinear bound states has the subject of a number of articles. The large time behaviour of solutions determined after solving Cauchy problem has been analysed by Ginibre and Velo in relation to decay properties.

The book is a treatment of nonlinear field equations, its mathematical properties and some important recent results intended for advanced mathematical physicists and mathematicians.

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Inverse Methods in Action

Proceeding of the Multicentennials Meeting on Inverse Problems, Montpellier, November 27th – December 1st, 1989

edited by P C Sabatier

Springer-Verlag : Berlin-Heidelberg-New York-London-Paris-Tokyo-Hong Kong, 1990
xiv+ 636 pages, 125 figures, price DM 138.00 (Hard cover), ISBN 3-540 51994-7

The present volume is an outcome of the deliberations that took place at the Conference on Inverse Problem held at Montpellier, France in the year 1989. The subject of discussion is broadly divided into eight categories. These are

(1) Tomographic Inverse Problem
(2) Distributed Parameter Inverse Problem
(3) Spectral Inverse Problem
(4) Scattering Inverse Problem
(5) Theoretical Imaging
(6) Wave propagation and Scattering Problems
(7) Inverse Method and Application to Nonlinear Problems
(8) Miscellaneous Problems.

In short, the book has encyclopedic nature so far as Inverse problem is concerned. Over the last two decade, immense amount of research have been done on the various aspects of Inverse problem. The lectures presented here, give a reasonable idea about the diverse applications of the subject.

The first part deals with the subject matter of Tomography in practice, giving details about its use in various domains. The second chapter deals with some theoretical ideas of inverse problem. The mathematical background of the inverse problem are presented in the third and fourth part of the book. On the other hand, fifth and sixth chapters deals with the topic of Imaging which is now a days a subject of prime importance. Some problems of general nature and application to nonlinear equations are discussed in the second part of the book.

These lectures are quite informative and references given therein do help the interested research worker. Due to the diverse nature of the subject matter, the book will be of use to a wider audience. Any serious worker in the field of nonlinear system, atomic or nuclear physics and geophysics would like to possess a copy of the book.

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